Mitigating Future Food Safety Risks from Agriculture Producer Level: Regenerative Agriculture Approaches in Thai Rice Production

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ABSTRACT:
Food safety risks in agricultural production are increasingly complex, driven by intensive farming practices, climate change, and chemical dependency. This ongoing project examines how regenerative agriculture practices at the producer level can mitigate these risks, drawing from a comprehensive case study of jasmine rice farmers in Northeast Thailand.

Background and Problem Statement: Conventional intensive farming in Thailand's Northeast region has led to soil degradation, excessive pesticide use (increasing from 2 kg/ha to 8.4 kg/ha), and declining productivity despite expanded cultivation areas. These practices pose significant food safety risks including chemical residues, antibiotic resistance, and environmental contamination affecting the food chain.

Regenerative Agriculture Implementation: A systematic regenerative agriculture program was implemented across more than 1,800 hectares involving 800 farmers (71% women) in six provinces. Key interventions included: (1) Site-specific nutrient management (SSNM) reducing fertilizer dependency while optimizing nutrition; (2) Biological pest control using *Metarhizium*, *Beauveria*, and *Trichoderma* species, reducing chemical pesticide applications by 200 liters in pilot areas; (3) Cover crop integration with sunn hemp (*Crotalaria juncea*) fixing 150-165 kg N/ha while suppressing 90% of weeds; (4) Minimized tillage and straw incorporation improving soil organic matter up to 46 g/kg.

Food Safety and Environmental Outcomes: Results demonstrate significant risk mitigation: biocontrol adoption reduced chemical pesticide dependency, while SSNM decreased nitrogen fertilizer application below recommended rates (194 vs. 450 kg/ha/year), reducing nitrate contamination risks. Water quality monitoring showed phosphate levels remained below contamination thresholds (0.04 mg/L average). Soil health improvements included balanced pH (4.11-8.41 range), enhanced microbial diversity supporting natural disease suppression, and increased carbon sequestration reducing GHG emissions by 4.5% in pilot areas.

Producer-Level Economic Viability: Economic analysis revealed sustainable profitability with average annual income reaching 1,616 EUR, significantly above the UN Decent Living Income benchmark (904 EUR). Cost savings from 30-50% reduced seeding rates and alternative income from cover crop seed production (7.2 ha sunn hemp cultivation) enhanced farmer adoption rates.

Policy and Scale-Up Implications: The project's success in exceeding farmer training targets on more than 800 farmers while achieving measurable yield improvements (maximum 5.0 t/ha vs. 2.8 t/ha baseline) demonstrates scalability potential. Weather station integration and Farm AI applications provide data-driven decision support, crucial for policy-level implementation across Thailand's 38.6 million rai rice cultivation area.

Conclusions: Regenerative agriculture represents a viable pathway for mitigating food safety risks at the producer level through reduced chemical inputs, enhanced natural pest control, improved soil health, and integrated technology adoption. The Thailand case study provides evidence-based protocols for scaling regenerative practices while maintaining economic viability, offering a model for regional food security enhancement and sustainable agricultural transformation.